Draft CEC PIER-EA Discussion Paper

Building California's Climate-Related Decision Support Capacity and Fostering Social Science Contributions

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Disclaimer

The purpose of this paper is to inform discussions among CEC staff, other state agency staff, non-governmental representatives, representatives of academia and other stakeholders regarding the state of the research on and ways to build California's climate-related decision support capacity and increase other social science contributions. In particular, this discussion paper will identify gaps in our understanding and recommendations for future research and practical initiatives with the end goal of supporting informed and systematic planning for climate change. Note that this paper is not intended as a research proposal and should not include recommendations regarding specific researcher projects.

1.0 Description of Topic

The interest in decision support – while much discussed recently in the climate context – is far from new, nor unique to climate change. In the climate change arena, it is an explicitly stated strategic goal for the national Climate Change Science Program since 2003 (CCSP, 2003) and reemphasized even more strongly in its recently updated strategic plan (CCSP, 2008). Apart from the still very limited federal level efforts in decision support (with some notable exceptions, for example in NOAA, EPA and some other agencies), climate-related decision support is a rapidly growing area of research and practice. It is directly in line with PIER's longstanding mandate to produce policy-relevant science, but also goes beyond it, in that decision support is not just for policy decisions, but for decisions at all levels of governance, in the private and public sectors. Below, the breadth and depth of decision support for all types of climate-sensitive decisions is described.

What is decision support?

Decision support is not a traditional research topic as, say, "impacts of climate change on the water sector" or "vulnerability and adaptation". Rather, decision support is a complex hybrid of (1) a different kind of *science* and (2) a different kind of *practice* in science, decision-making, and at the interface of science and decision-making. Conventional notions of "decision support" typically reduce the concept to an activity that focuses on providing data, tools (typically computer-based), and other types of information allegedly useful to decision-making. Both the social scientific study of the interactions of scientists and decision-makers/policy-makers/managers (hereafter, "practitioners"), as well as the (frequently published) practical experiences of scientists working directly with practitioners, have considerably opened up our understanding of

2

decision support. Most importantly, that literature has shifted our understanding of decision support from its exclusive "product" orientation to one that includes also a critically important "process" focus. In a forthcoming report from the National Research Council which synthesizes the extant literature on this topic, decision support is thus more broadly conceptualized:

Decision support consists of processes, activities, products, and services that cause decision-relevant knowledge and information to be produced and to be considered in decision-making. Decision support includes (a) ongoing communication among producers and users of decision support products and services; (b) production of decision-relevant information; (c) creation of products and tools based on this information; (d) dissemination of these products and tools; (e) efforts to encourage the use of decision-relevant information and tools; and (f) development of organizations, networks, and institutions for the above purposes.

This comprehensive conceptualization of decision support places the relationship between scientists and practitioners at the center and views the usefulness of any information developed to support decisions as a function of the quality of and institutional support for that relationship.

Decision-relevant knowledge or information, if actually used in making a choice, can result in better results for the decision-maker than would likely occur if the choice were made without this knowledge or information.

To increase the chances that scientific knowledge becomes relevant or useful to and used by practitioners, a whole range of activities or *decision support services* may be required. They may include (but are not limited to):

- Various communication services (including framing issues, translating and repackaging research in accessible ways, interpretation of existing technical understanding, education and outreach, dialogue facilitation, visualization, etc.);
- Mediation and information brokering;
- Use-inspired research (Stokes, 1997) (filling decision- and context-specific knowledge gaps identified by potential users of the research findings);
- Basic research (filling fundamental knowledge gaps uncovered in the course of scientist-practitioner dialogues);
- Decision structuring and problems-solving assistance, sometimes including science-based advocacy of policy or management options; and
- Various kinds of evaluations (e.g., of the effectiveness of decision support, stakeholder engagement processes, policy outcomes).

A *decision support system* thus consists of the individuals, organizations, communication networks, and supporting institutional structures that organize, enable, and provide

¹ Because the report is still being drafted and revised at this time, this White Paper will not cite the NRC report directly, but a reference to it is included in the Bibliography (NRC, forthcoming). The author is a member of the NRC panel and involved in writing the report, thus close to the underlying discussions and the panel's evolving understanding of decision support. To avoid overwhelming this report with references to a diverse and wide-ranging literature, only the NRC report is cited here.

decision support products and services, develop the knowledge needed to produce those products and services, as well as the resulting knowledge and the associated information products. The decision-relevant information and knowledge products by themselves do not constitute a decision support system.

What makes decision support effective?

Insights from practical experience and from studies of the science-practice interface suggest that effective decision support stands on several essential foundations: good relationship building skills (both, on the scientists' and the practitioners' side and among them); a basic interest, desire and openness to mutual education and learning; effective leadership; often a persistent institutional home (e.g., some kind of center known to provide decision support services); and skilled and effective communication among all involved.

Additional common lessons from existing decision support activities suggest that collaborative problem definition and ongoing reassessment of support needs are a must. Decision support also requires active working across and consciously managing of the boundary between the very different worlds of science and practice (both function by different rules, norms, cultures, languages, incentive systems and so on). The most successful efforts are multi- or interdisciplinary (in terms of the science) and foster crossagency collaboration (on the practitioner side). Together, participants try to overcome the scale mismatches and disconnects between level of scientific analysis and that of management and governance. Scientists and practitioners also inform each other of, respect, and creatively work with the wider decision and scientific context. Additional insights relevant for decision support from research and experience suggest that social networks are critically important for access to expertise and stakeholders, learning, exchange of decision relevant information, and for the spread of innovations in technology and practice. While establishing decision support relationships takes time and should be well practiced maintained over time, windows of opportunity to make use of potentially relevant information are not always open. When they open, timely insertion of relevant information into the decision processes is essential. Effective communication of science to different audiences, meeting the needs of different audiences or constituencies is just as essential as the information itself. communication must motivate and enable action with practically relevant help and support, i.e., help overcome barriers to action, or else it will be ineffective in supporting decision-makers.

What are climate-related decisions?

Climate-related decisions are choices made by individuals, businesses, governments and other organizations, the results of which are likely to affect and be affected by climate variability and change. The people making the choices may or may not be aware that they are climate-related.

Clearly, such decisions are already being made, every day, in every sector of society. Any decision that has implications for the release of greenhouse gases into the atmosphere (foremost in the energy, agricultural, transportation, waste and industrial sectors) or that changes land use and cover is a climate-related decisions (here summarized as *mitigation decisions*).

Equally, climate-related decisions (here summarized as *adaptation decisions*) are also those that involve changes in: the degree of exposure to climate risks, such as siting decisions (e.g., developing in a floodplain, providing shade to farm workers); in the degree of sensitivity to climate risks (e.g., breeding more heat-tolerant crops, elevating homes in coastal areas subject to sea-level rise); in the coping or adaptive capacity vis-à-vis climate risks (e.g., providing insurance, facilitating innovation and learning); or that lower or elevate the barriers to coping and adaptation (e.g., statutory changes to land use regulations or species protection, providing technical assistance, extending planning horizons). These types of decisions are made at the individual/household level, the local/community/city/county level, at the organizational level (where the reach can vary from local to multi-national), at the state, national or international levels. At each of these levels, the type of information needed is different. It is therefore impossible to produce one decision support product that is useful at all levels, in all sectors, or different types of decision-makers.

Each of these management or policy changes goes through various stages and involving different individuals (from the initial problem formulation, to assessing it, developing response options, implementing or operationalizing them, evaluating and – if needed – revising them. At each of these different stages in the decision process, different decision support services is typically required from science.

It becomes also clear from this brief sketch that relevant knowledge for climate-related decisions includes knowledge about climatic processes and trends, but also about vulnerabilities and impacts, as well as the costs and feasibility of mitigation and adaptation responses (technologies, planning, policy changes, statutory changes etc.). Building California's climate-related decision support capacity thus must go far beyond perfecting climate change projections or downscaling them to finer and finer resolutions. Rather, it must extend to embrace all relevant physical, natural, social, economic, policy, and engineering science that should inform the state's mitigation and adaptation choices at different scales and at different stages in the decision-making process.

From this brief overview, it becomes clear that the scope of decision support is truly vast, the variety of decision support needs is daunting, and decision support needs are already and will continue to grow rapidly, as people become more aware of the climate risks they are facing and need to manage. What precisely these decision support needs are is only partially known at present, will change over time, and is impossible to summarize in this paper. The science of decision support suggests that these needs, and how they can be met over time, must be defined and continually reassessed *in collaboration* between decision-makers, scientists, and sponsors. The remainder of the paper thus is more categorical than specific, identifying basic principles of effective decision support and generic needs rather than providing exhaustive lists for different sectors or scales of decision-making.

2.0 Summary of PIER Program Research and Accomplishments to Date on Climate-Related Decision Support

The PIER Program has funded only a small number of studies to date that fall broadly under the heading of "decision support". These are discussed here in some detail to extract larger lessons on the existing strengths and opportunities in decision support,

and to identify lessons for building it where it is currently lacking. These lessons are entirely in line with the general findings summarized above, but also specific to California.

Decision support for mitigation decisions

One PIEREA-funded project (Sathaye and Murtishaw, 2004) focused on individual consumer decisions to purchase or use energy-efficient appliances (i.e., mitigation decisions). It explored the importance of factors that "prevent consumers from taking actions that would be in their private self-interest, that is, would result in the provision of energy services at lower cost. These factors include lack of information about energy efficiency opportunities, lack of access to capital to finance energy efficiency investment, misplaced incentives which separate responsibilities for making capital investments and paying operating costs, hidden costs, transaction costs, bounded rationality, and product unavailability." The paper developed a conceptual framework for understanding the roles of these factors, and offered a methodology to quantify their effects on costs and potentials of buying compact fluorescent light bulbs and energy-efficient clothes washers. The authors found that the big gap between technological potential and cost effectiveness of investing in energy-efficient technologies on the one hand and actual adoption of these technologies by consumers on the other can be explained partially by the cost of initial investment (or replacement), consumer preferences for non-energy attributes of these technologies, and maybe most importantly by the information processing and transaction costs, i.e., by cognitive limits of consumers learning about, calculating the benefits of using alternative technologies, and going through the trouble They suggested that "government interventions to reduce of replacing them. information and transaction costs can significantly increase diffusion of resourceefficient products" (Sathaye and Murtishaw, 2004, p.30).

While this type of research is directly in line with the Energy Commission's policy interests (and additional energy- and mitigation-related research is produced in other PIER research programs), it is a good example of research touching on climate-relevant consumer behavior—an area perceived as neglected by several of the experts consulted for this paper. It is unclear whether or how the findings of this study have informed state outreach efforts around energy efficient appliances. If they have not been used yet, it seems that these sorts of findings could directly inform outreach campaigns during energy crises and - maybe more importantly - in non-crisis-driven campaigns such as "Flex Your Power" (http://www.fypower.org/). Focused on consumer behavior change, economics does and will continue to provide important contributions to policyrelevant questions. A broader set of disciplinary inputs (e.g., from psychology, sociology, of the policy sciences) is missing from the research portfolio to date, but would add complementary and equally necessary inputs in the future on the design, implementation and evaluation of such outreach and behavior change campaigns (related to mitigation or adaptation-related choices). One overarching lesson emerging from this type of research then is that climate-related decision support (in this case for mitigation decision) does not only require climate science, but a number of other social, natural and engineering sciences.

Decision support for adaptation decisions

A second set of studies is focused on adaptation-related decisions. The first of these in the PIER portfolio (with additional support from NOAA and CALFED) funded the initial development of a decision support tool, including its on-the-ground testing in a demonstration project called "INFORM" (Integrated Forecast and Reservoir Management). The project analyzed the application of modern hydrological forecasting and decision analysis methods to the operation of several California reservoirs (e.g., Georgakakos et al., 2005).² At present, in the second phase of INFORM (funded by PIER and DWR), the researchers are improving the model and are performing additional demonstration work (using years with different hydrological conditions) for five or more reservoirs in Northern California. The project is expected to show operability under current levels of climate variability (for future continuing work, see below).

The study is an excellent example of ongoing engagement between researchers and decision-makers in developing and perfecting the tool, their mutual education, and the importance of trust and transparency in building decision support capacity. The project is demonstrating the benefit of using modern decision support tools in resource management, and is teaching important lessons about the institutional constraints and ways to foster changes in decision protocols, which allow for innovation, learning, and resulting improvements in management outcomes.

Another relevant study to the question of decision support emerged out of the growing interest in adaptation and preparing for the unavoidable impacts of climate change prior to the 2006 Governor's Scenarios Report. Luers and Moser (2005) presented a framework (called "the AAA of adaptation") to assess the on-the-ground preparedness for climate change of resource managers, including their Awareness of climate change risks, Analytic capacity to process relevant information and develop adaptive responses, and the adaptation Actions actually taken to address climate-related risks. Empirical testing of the framework was relatively limited in this paper. A follow-up study, also funded by the PIER Program, tested that framework in the coastal sector to assess coastal managers' preparedness for climate change (Moser and Tribbia, 2007a,b,c). These two project resulted in several peer-reviewed publications (Moser and Luers, 2008; Moser, 2007; Moser and Tribbia, 2006/2007; Tribbia and Moser, 2008).

The study by Moser and Tribbia in particular examined the decision support needs of coastal managers (e.g., planners, permitting officers, engineers, environmental resource managers, among others) – the first and only study funded by PIER to do so, and thus directly address the question that is the subject of this paper. Several important findings emerged:

 While coastal managers already use environmental, weather, climate and waterrelated information in their daily work, almost none of them at present use projections of *future* climate variability and change, or projections of sea-level rise under different climate scenarios in their planning and management decisions today.

² This project is the only explicitly mentioned decision support-focused project in the 2003 PIER research plan (Franco et al., 2003).

- Frequently, managers have the greatest difficulties with accessing existing yet somehow unavailable information, rather than due to the complete lack of information.
- More than 70 percent of coastal managers participating in the study said that they either never or only rarely use the typical outlets for scientific information (primarily peer-reviewed scientific journals), thus are not benefitting currently from existing expert climate change-related knowledge.
- Most managers use rather simple tools to process or display information in their management duties today, with limited capacity to use more sophisticated analytical, modeling, or forecasting tools (often presented or used by academic researchers). Capacity would need to be built if interpretation and use of climate change-related information required this type of information processing.
- The most useful knowledge resource desired by managers is help with determining what elements of their community are most vulnerable to the impacts of climate change. They expressed a desire for more than just information, but also interactive forms of learning (e.g., training workshops, web-based clearinghouses and manuals), forums for discussing this information, and action-oriented case examples to explore and learn about management options for adaptation.

In a companion paper resulting from this project, the team identified critical barriers to adaptation actions. "Local managers overwhelmingly see local monetary constraints as the leading hurdle to addressing global warming challenges. This barrier is followed closely by insufficient staff resources to analyze and assess relevant information, lack of funding from state and/or federal agencies to prepare a plan, the view that currently pressing issues are all-consuming, and insufficient staff time. More than half of the respondents also viewed the lack of a legal mandate to take global warming into account as a major hurdle" (Moser and Tribbia, 2007b, p.3). Mechanisms to overcome these barriers may include:

- State agencies make climate change and related inundation risks a higher priority in their own planning and operations and support and/or require local jurisdictions to include such considerations in projects that require state approval (i.e., create a demand for climate change-related information)
- State and federal agencies provide guidance, motivation, information, and help with incorporating scientific information into future management and planning, such as:
 - Legal mandates to plan ahead and account for climate change (impacts) in long-term plans and decisions, accompanied by funding mechanisms and additional staff resources to implement such mandates
 - o Regular doses of relevant and accessible information on the latest climate change science and impacts, especially that relevant to coastal areas
 - A range of opportunities for coastal managers to learn from each other about adaptation strategies, vulnerability assessments, and funding mechanisms.

These findings are discussed here at some length as they are indicative of decision support needs more generally³ and lead to one critical insights about building California's decision support capacity: decision support for local resource managers and planners is not just about providing certain types of information, but a wider set of services (trainings, education, two-way communication, capacity building, technical assistance, implementation help, and so on).

The above-cited studies on the degree of preparedness to deal with climate change impacts have had far-reaching impacts, including:

- Raising awareness among local and state-level decision-makers, state legislators, and in the wider public of the degree of un-preparedness for climate change in one of the most vulnerable sectors in California;
- Bringing attention among state, local, and federal agency staff (e.g., in NOAA) to the need to provide far better decision support to resource managers if they are expected to address climate change risks; and
- Creating motivation within the PIER Program and in other state and federal agencies to support additional social science research to better understand adaptation-related decision support needs.

While not the only possible way, the approach used in this research proved to be a costeffective way to identify decision support needs in a climate sensitive sector.

Research on Science-Policy Interactions: Larger Lessons for Decision Support

A final study funded under the PIER Program that falls broadly under this rubric is a paper on the history of science-policy interactions at the highest state level (Franco et al., 2008). It documents the important role that state-, federal- and NGO-led scientific assessments of regional climate change impacts have had in generating awareness and concern over the risks of climate-related impacts among California policy-makers. Clearly guided by the state's existing framework of energy and air quality policies and commensurate with non-climate-related political motivations, the impact of credible, widely and accessibly communicated, and responsive science on individual policy leaders and the policy process over the past 20 years is extensively documented. The study emphasized several key lessons relevant to the question of providing decision support (at the state level):

- While the earlier assessments were not mandated, the most recent (the 2006 Scenarios Project) was embedded in a mandated, comprehensive report that outlined a set of strategies for managing climate change through aggressive mitigation and adaptation approaches, thus creating a direct link between science and legislative action;
- The Scenarios Report was initiated and completed in less than eight months, which was made possible by extremely efficient project management and extraordinary commitment of all engaged. In the end, the effort was extremely responsive to state policy-maker needs and policy-making windows or

Draft CEC PIER Discussion Paper – Building California's Climate-Related Decision Support Capacity and Fostering Social Science Contributions

³ Studies conducted in the forestry, agricultural and coastal sectors in other states, using the same survey and interview protocol, found very similar situations and needs for decision support.

opportunity, but the short timeline prevented extensive stakeholder involvement;

- The dissemination of its key findings to the scientific community (in a special issue of the journal *Climatic Change*, and to policy makers and the wider public through an easily readable and attractive outreach brochure (California Climate Change Center, 2006) was planned from the beginning (not, as is often the case with other research, a hasty after-thought);
- The communication and outreach was critically enabled by the presence and engagement of local scientists, who were able to participate in multiple briefings with representatives from state agencies, private sector groups and the media;
- The Scenarios assessment was broader than previous efforts, including the work of 70 physical and social scientists from academic, government and other organizational units and yet, not all of policy-makers' questions could be answered in the short time available;
- Connections between the scientists and the technical staff at different state agencies were established or reinforced, thus providing the ongoing decision support connections necessary to improve the quality of future long-term planning in California; and
- Comprehensive efforts such as these involve a wide network of scientists involved in research far beyond what a program like PIER can fund, thus requiring sustained support from federal and international sources (Franco et al., 2008).

Again, the insights gained from this effort are discussed here in some detail as they point to several larger lessons about building California's decision support capacity. First, with significant attention, commitment, project management, funding, and concerted communication effort, extraordinary decision support can be leveraged on short notice. California already has important experience and capacity for doing so at the state level in support of high-level policy decisions. A second insight, however, is the apparent disparity that emerges from the above mentioned studies between the decision support capacity at the state level versus the local level. Discussion below will refine this observation.

A third lesson reiterates a conclusion drawn above: scientific information alone, if not also accessibly and purposefully communicated to the right decision-making audiences may be interesting from a knowledge perspective, but does not constitute decision support.

Fourth, mandates create strong information demands from potential information users, critical focal points around which scientists must deliver their information, and - through embedded timelines – essential windows of opportunity where scientific information can be influential in the policy-making process. Once that window is passed, even the most interesting findings have lost their decision-maker audiences.

Fifth, the availability and engagement of local scientists is essential for the credibility and legitimacy of the science. Because they are available to engage repeatedly with decision-makers in the research design, analysis, review and communication phases, the produced research is also likely to be much more salient or relevant to decision-maker needs, enabling them to make better-informed decisions. These criteria – credibility,

legitimacy, salience and efficacy - have been found to be essential ingredients in effective decision support (NRC, forthcoming).

3.0 Non-PIER Accomplishments in this Area and Opportunities for Collaboration

The literature on climate-related decision support – i.e., on the processes, networks, institutions, and on the knowledge and tools needed to effectively enable and inform decision-making related to climate variability and change – is huge, dispersed, and rapidly growing in light of the increasing awareness of climate change and its attendant risks. The reader, again, is referred to the forthcoming report by the NRC for a synthetic review and ample referencing. Maybe more relevant here is to mention some examples of practices, institutions and networks already established in California that either already provide climate-related decision support, or provide other types of decision support and therefore provide opportunities for collaboration.

One model frequently cited for effective climate-related decision support is the effort of seven nationwide established Regional Integrated Sciences and Assessment (RISA) centers, funded by the National Oceanic and Atmospheric Administration (NOAA) (http://www.climate.noaa.gov/cpo_pa/risa/). California has one of these centers (the California Applications Program (CAP; http://meteora.ucsd.edu), housed at Scripps, under the leadership of Dan Cayan). While its own institutional entity, its operation is difficult to distinguish from that of the California Climate Change Center (e.g., developing climate change and sea-level rise projections, better understanding the implications for climate change for water supplies and management). Unlike other RISAs, the CAP does not have the support of social scientists or the personnel capacity to expand much beyond its current research portfolio. Direct interaction with local-level decision-makers is limited. Its contributions to PIER-sponsored work (e.g., the scenarios projects) at the state level, however, have been extensive.

Another model of decision support—which has not been explicitly focused on climate variability and change in the past, but for which collaboration and expansion of the focus to climate-related decisions may be possible—is cooperative extension (http://ucanr.org/index.cfm). California has a series of statewide and regional programs and centers (all under the University of California Division of Agriculture and Natural Resources) to assist agriculture and forestry⁴, including several regional research and extension centers (RECs) and Cooperative Extension offices in every county. For coastal and marine resource management, California is home to two Sea Grant Extension Programs. In addition, there is a single (!) extension specialist for the entire state of California specifically focused on wildfire management. Extension programs have a long history of providing decision support at the local level. Institutional and financial shifts over the years, however, are changing how extension works, how important it is relative to other information sources, how extension agents interact with potential information users, and who their clientele is. It is unclear, but

⁴ They include the Agricultural Issues Center, the Center for Water Resources, the Farm Safety Program, the Integrated Hardwood Range Management Program (focused on oak woodlands), the Integrated Pest Management Program, the Mosquito Research Program, the Small Farm Center, the Sustainable Agriculture Research and Education Program, and the Kearney Agricultural Center.

should be explored, whether and how PIER-sponsored decision support could link into this existing network.

State agencies do not at present have a single "go-to" institution to assist them with research and technical assistance that cannot be provided in-house. To some extent, such needs are met through consultants. While relationships and reputation develop over time, such support is typically (and often legally required to be) project- or issue-specific and term-limited. Informal conversations with agency personnel over time suggest that this form of decision support is important to augment in-house expertise but does not meet all of the decision support needs among stage agencies: social science information in support of climate-related decisions is extremely limited from consulting services to date, and some physical science needs go unmet as well; funding constraints may not allow more extensive use of these services; in-depth and state-of-the-art understanding of the climate change and related fields may be lacking; and consulting relationships may be too short-lived to build the necessary trust and mutual understanding to affect the type of research undertaken and the decision-making processes using relevant information.

Finally, a number of academic research centers exist in the state that engage in relevant research, but that are not yet connected into PIER-sponsored climate change research. They could become important resources and collaborators in the future to enhance the scientific capacity and input relevant to decision support (especially in the social sciences). Examples (far from exhaustive) include the National Ocean Economics Program at MBARL⁵ the University of California Institute for Mexico and the United States (UC MEXUS) at UC-Irvine,6 UC-Davis's Sustainable Transportation Center⁷ and Center for the Study of Regional Change⁸ – which explicitly tries to connect research with planning and resource management—and the Program on Reducing Vulnerability to Climate Change (currently under development at Stanford University). Such centers could become part of a future network of partners in research and decision support of which the Scripps- and Berkeley-based California Climate Change Centers would be the hub. While a network of such existing centers would embrace a substantial amount of relevant social science capacity in the state, care would need to be taken to not miss others unconnected to them, and ongoing engagement would need to be fostered (as discussed in Section 6.0 below).

4.0 Research Underway/Committed to via PIER Process

In the 2003 Strategic Research Plan (Franco et al., 2003), work was proposed to expand upon the PIER-funded decision support demonstration project "INFORM" (Integrated Forecast and Reservoir Management) described above. Work on this project continues at present and will go on into a third phase. The project team (Georgakakos and colleagues) will use 50 years of simulated climate conditions in the historical period and 50 years of conditions by the end of the 21st century (simulated by climate models, and using the common set of climate change scenarios used elsewhere in PIER-funded

⁵ See http://noep.mbari.org/.

⁶ See http://www.ucmexus.ucr.edu/.

⁷ See http://stc.ucdavis.edu/.

⁸ See http://regionalchange.ucdavis.edu/.

projects) under existing water management rules and modified rules developed with the INFORM system. The project hopes to determine the capabilities of the INFORM system as a coping/adaptation climate change tool.

Another project currently underway is conducted by Purkey and colleagues from the Stockholm Environment Institute (SEI). They will explore how the Google Earth platform can be integrated into its own weADAPT system (http://www.weadapt.org/ and http://www.weadapt.org/ and http://www.weadapt.org/ and http://www.weadapt.org/ and http://www.weadapt.org/ and http://www.weadapt.org/ and http://www.weadapt.org/ and improve the utility of both tools for California in the area of adaptation to climate change. The tool may be used in support of research, decision-making, and information dissemination. SEI will also translate selected PIER funded studies to the weADAPT and Google Earth platform, and enhance an adaptation study that SEI is conducting for the National Oceanic Atmospheric Administration (NOAA) so that its results will also be available via weADAPT/Google Earth. Visualization tools such as these are powerful tools and must be explored not just for their technical feasibility but also the ethical and legal implications of their use as well as for their underlying social and natural science components.

5.0 The Wider Landscape of Social Science Contributions to California's Climate Change Science and Policy Agenda

To address climate change effectively, climate science and related physical/natural science research are essential but won't suffice. Mitigation and adaptation decisions need answers to questions on economic costs, technological feasibility, social acceptability, policy design, equity, power and political risk, ecological consequences and so on. Fundamentally then, managing climate change opens difficult questions on managing risks to society and its ecological support system. The ecological, economic and social/behavioral sciences are indispensable in contributing to these answers. To date, however, the social and behavioral sciences have been largely absent from the climate change discussion in California (and in many other places). This situation is far from unique to California. It is in fact the perennial complaint that the social sciences are insufficiently engaged on climate change issues.

This section briefly summarizes insights offered by the experts whose views were solicited on the lack of social science participation in (California's) climate change agenda. While likely incomplete, the list of reasons is telling and useful in seeking remedies in the future.

Characteristics of social science research

- The social sciences traditionally have conducted research on predominantly small-scale human issues; for many, large-scale issues like climate change are not mainstream in their disciplines, with some notable exceptions (e.g., global policy frameworks; demographic modeling, north-south equity issues).
- Some social scientists who are working on climate issues have a prejudice for working in areas that are deemed to be more vulnerable to climate change than wealthier parts of the world, such as California.

- Social scientists have been slow to update their own research agendas to respond to emerging societal needs; they tend to find it difficult to be forward looking into the 21st century rather than be present and past-oriented.
- Structural impediments (e.g., tenure requirements) continue to make it difficult for social scientists to address global issues or to work at the science-practice interface.
- Social scientists don't market themselves very well in terms of their contributions to the climate change agenda; by and large, they don't "bang on the door" and demand inclusion; some experts (inside and outside the social sciences) view them as having a "minority complex" vis-à-vis economics and the natural sciences, they feel they have to still prove their relevance.
- The subject matter of social scientists humans some would argue is far less predictable and therefore knowledge about them less replicable than that about some physical systems. This makes them less attractive or more easily dismissible from a policy/management perspective. Many social science findings depend on assumptions that are changeable and a matter of choice (e.g., discount rates are a matter of human judgment while assumptions about climate sensitivity are independent of judgment, but as of yet incompletely known).
- Some social sciences are less quantitative, and compared to the natural sciences bound by the laws of physics -- theoretically less well grounded; this feeds into a broad "soft science prejudice."
- Now, as researchers and decision-makers are waking up to the importance of the human dimensions (drivers, impacts, responses), there is a deluge of requests for inputs, but the research capacity is not there, nor can the non-linear increase in demand be met over night.

Social science coordination or programmatic support

- At present there is no programmatic focal point for social scientists in California on climate change, even if many individual researchers do independent research on the topic. For example, there is no equivalent to the International Human Dimensions Program (IHDP), which coordinates and facilitates synthesis of social science research related to global change, and is increasingly trying to link human dimensions science to policy.
- The UC Chancellor's office has a fund for policy-relevant research, which is distributed every year, but some local scientists see it as "pork barrel" with very little relevance to ongoing policy questions. Scientists claim policy-relevance, but are not required to actually interact with decision-makers to increase relevance. The research funded through this fund is not focused on climate change.
- Some perceive a lack of leadership in the UC system to show what the system has to offer to the state on climate as on other policy issues.
- Years ago, a California Policy Dialogue was initiated through USC but did not receive any funding from the legislature and the university could not sustain it. Its failure spawned the idea for a "Brookings West"-type institution. The Public

Policy Institute of California was the result, but opinions on its relevance and importance as a focal point for social science research vary. Some view it as too narrowly defined, not working effectively with the legislature and not widely respected by policy-makers, while others see it as an important voice for social science research. Its work is not deeply linked with social scientists across the state.

• Many scientists in relevant neighboring, but presently not climate-focused fields are not even aware of what the state is doing on climate change.

Framing of climate change

• By and large climate change has been framed as a (physical) science issue in California and elsewhere, rather than as a social problem; as a result, physical and natural scientists are deeply engaged, social scientists are not.

Support for social science research on climate change

- The long-standing dominance of natural sciences in federal and state agencies leads funding institutions to marginalize social sciences. This is changing slowly and only most recently.
- California's PIER and other programs have not explicitly invited broad participation or specific social science inputs to date into its climate change research.
- PIER calls for proposals do not require that research proposals should be multidisciplinary with an explicit and well integrated social science component (i.e., a collaborative, multi-disciplinary problem analysis).
- Calls for proposals may not have reached or been directly directed toward relevant social sciences (through listservs or other distribution lists).
- Some experts suggest that there needs to be a longer-term commitment, not just a one-off RFP cycle or a conference to engage social sciences for the long-term.

The policy climate

 Some social scientists perceive the policy climate around climate change or related issue areas (such as water management) as extremely politicized and shy away from engagement with it

From this cursory compilation of reasons for why the social sciences have been largely absent from climate change research and why they have not helped to inform climate-related decisions to date, it becomes clear that some of these challenges are deeply structural and do not lend themselves to quick fixes, while others can be addressed more easily. If the PIER program and other state agencies are serious about including social sciences in future climate change efforts, collaboration in addressing the deeper structural problems seems the most promising way forward.

6.0 Gaps in the California's Climate-related Decision Support Capacity

By way of summarizing the forgone discussion, one may ask "what are the barriers to providing effective decision support?" A mere decision support as information product

focus would answer this question by pointing to a lack of specific information and hence the need for more research, and some suggestions along these lines are given below, but are and cannot be exhaustively enumerated here. The broader perspective promoted here, which conceptualizes *decision support as interdependent process and product*, points to the maybe more important structural and institutional challenges that prevent science-practice interactions from becoming commonplace and "best practice" in both the science and the decision-making camps. These impediments include institutional and legal (structural) barriers, organizational barriers, cultural barriers, omissions in professional training, education and mentoring, human resource constraints, lack of funding for particular types of research, but also for communication, institution building, communication, and other resources, time constraints, and other pressures. All too often the confluence of constraints and barriers lead to bottlenecks where the rapidly growing demand for decision support can simply not be met by the relatively few who are exceedingly willing and skilled.

From that perspective, it becomes clear that building California's decision support capacity requires attention to several key elements, not just research. Establishing mandates to use climate-relevant information in decision-making will quickly foster an information need, but this will need to be matched by the necessary leadership and adequate training for those who would respond to this need and provide in decision support. In addition, institutional changes and institution building, a substantial increase and redirection of funding into decision support, the use of intermediary organizations between science and decision-makers where advised, building new and connecting to existing networks, and academic and agency recognition of decision support as much needed and respectable activities will all assist in the building of California's decision support capacity. It is not assumed that PIER can achieve these changes alone, but PIER, the Energy Commission, and Resources Agency can play a central, initiating, promotional, and maybe coordinating role among the many players that should be involved. Specific suggestions follow.

Promoting a Different Way of Doing Research

Academic research occurs in a professional, institutional, and cultural context that favors independence, distance from practice-oriented or politically sensitive decision questions and policy matters, and curiosity-driven inquiry aimed at pushing back the frontiers of knowledge. While researchers frequently enter their research fields out of deep motivation and care for the state of the world, the academic reward system typically does not provide incentives (and instead, sometimes disincentives) to engage with decision-makers. This is a difficult and real hurdle to overcome, especially for untenured faculty. Similarly, there are still only few institutions that foster and reward multi- or inter-disciplinary research. While this is all slowly changing, the PIER Program must seek out, and make it attractive to collaborate and engage with, scientists willing to take what some might still consider professional risks. This will help along the paradigm shift needed in academia. Leadership at the highest levels in the UC system, prestigious rewards from leading institutions (e.g., the California Academy of Sciences), and even state-sponsored, well publicized but not necessarily remunerative rewards for scientists engaging on important policy questions could all foster the needed changes.

To the extent scientists are (already) willing to engage on climate policy- and management questions at different levels (state, regional, or local), PIER research funds could require well-integrated (as opposed to "stapled together") multi-disciplinary proposals and stipulate stakeholder engagement at various stages in the project development/design, analysis, review and communication phases.

Supporting Specific Types of Research

PIER and other research sponsors can do much to engage social sciences and to require that different types of research relevant for decisions are conducted. Fundamentally, a reframing of climate change not merely as a physical or natural science problem but as social/societal problem will go a long way toward attracting social scientists and a different kind of discussion. Dedicating some research funds exclusively to social scientists (for specific suggestions see below) and distributing requests for proposals to a much wider distribution list is important. Such research can help answer specific questions, but it is important to not stop there. Experts interviewed for this paper emphasized that "just one more piece of the puzzle" is insufficient. Some dedicated research funds thus should be for projects for which multi-disciplinary, well-integrated contributions from a range of disciplines, including the social sciences, is required. Stakeholder involvement (i.e., the decision-makers whose decision this research is to inform) should also be mandated. Such involvement should begin with the formulation of RFPs and the project design, and therefore will inform the research agenda funded by PIER and other state programs. The examples for specific research ideas are therefore clearly incomplete, but offer some examples of the kinds of issues that require further investigation. A distinction is made between research on decision support, which can help inform how best to design decision support for the state, and research for decision support, which will produce decision-relevant information.

Research on decision support

This area of research is a core social science research arena. It focuses on the interactions between scientists and practitioners and could help improve existing decision support activities, suggest additional, new decision support activities and ensure their effectiveness, and design decision support institutions to contribute to the long-term stability and capacity of decision support in the state.

- Comparative research of the RISA and extension models of decision support to better understand each system's respective strengths and weaknesses. Which model (among these and maybe others) works best under which circumstances, in which contexts? Insights could be used to build and further foster decision support capacity in California in the future.
- Extension services are long-established institutions, but they are also changing with the advent of the web, changing budgets, personnel overturn, shifting priorities and the needs and types of information users. How are the decision support services changes? Is the effectiveness changing?
- There is a bottom-up, inclusive, participatory bias in the emerging paradigm of decision support yet the decision-making/management regimes in some sectors or institutions is militaristic and top-down (e.g., fire fighting, some engineering

- contexts). What happens at the interface between the decision support and decision-making institutions?
- When is it better to have intermediary (boundary) organizations between science and practice, when are they not needed? What makes some betters than others?
 Can we identify characteristics that decision support institutions should have that increase their effectiveness?
- How can new knowledge networks be built or existing ones used and adapted for climate change purposes? What are the challenges involved and how can they be overcome?
- Identify decision support needs (including which, when and in what formats information is needed, but also what other types of support are needed) in all climate sensitive sectors and improve the understanding of the decision context in which decision support is provided.
- Inventory of decision support providers in California how can they best be networked? Where are the gaps that no one is covering at present?
- How can structural incentives be set to establish a learning culture and orientation in decision-making institutions (e.g., comparisons with charter school experimentation, quality circles etc.), as climate change and the constantly changing baselines will require more active (and quicker) learning to occur.
- Test the hypothesis that when there is trust and good relationships between researchers, decision-makers and stakeholders, collective response (mobilization of collective knowledge resources and other social capital) is more likely. Involve anthropologists and organizational theorists to better understand collective response to climate risks.
- Much climate change information is uncertain and will always be. Robust decisions will need to be made in the face of this uncertainty. Communicating this uncertainty is critically important, yet also a research frontier. How do people respond to uncertain information? How should uncertain information be communicated (and what other support is needed) to elicit the most appropriate response? How can we help individuals make decisions in an information overload context and where they lack an appropriate mental model of the problem?
- Can individuals, citizens, stakeholders be engaged in the monitoring of key environmental and social indicators as a way to obtain decision-relevant information, educate them, create a desire to engage, and be involved in decision-making?

Research for decision support

Specific research suggestions for specific sectors are not made in this section. Useinspired research needs are abundant, however, and should be identified and refined in direct cooperation with the decision-makers.

• To date, there is uneven and only partial scientific input into mitigation and adaptation decisions, especially from the social sciences. According to Stern

- (2006), "There is little hope of achieving such ambitious [climate change policy] goals without understanding why policies fall short and how to improve their effectiveness. That's where the social and behavioral sciences come in." Thus, much social science research is needed, e.g., on how much change can be expected from any particular policy option (in the real world, with real energy consumers, real resource managers, actual markets, and organizations), on how to design and choose among policy options for maximum effect, and on how to foster appropriate implementation.
- There is little if any research to date in California on the interaction between the state's mitigation strategies and emerging adaptation decisions. This is needed to prevent unintended consequences. To help inform decisions, an "mitigationadaptation interaction assessment" protocol (incl. linkages across sectors, scales, stakeholders, positive synergies and negative trade-offs) should be developed for use by decision-makers prior to designing and implementing a policy.
- There is a need to identify robust management strategies that can operate in spite of significant uncertainties (not just in physical climate, but also the social and ecological environment), especially for high-stakes, large-scale investments where there is a significant risk of irreversible losses.
- What are the institutional (e.g., regulatory, statutory, governance structures) opportunities and constraints to adaptation decisions in various sectors. Are the barriers de facto limits, can they be changed or are there ways to work around them? Are there instances where decision-making processes can be centralized (e.g., to ensure early climate change consideration), others where they should be decentralize to increase response flexibility and creativity?
- Most resources are managed through some form of multi-level governance what are the mechanisms, where are the gaps, needs, barriers to respond in an integrated, efficient, and flexible manner to the challenges arising from climate change?
- To help mainstreaming climate change in decision-making, can we draw "decision maps" of actual decision procedures to better pinpoint the high-level leverage points for ongoing, periodic or occasional decision processes? Can we identify the leverage that different institutions at different levels of governance actually have to affect change?
- More research is needed on how to increase demand for new technologies and practices through policy, and on how to improve effective implementation of policies. What impedes, what fosters putting ideas and policies to practice?
- Many mitigation and adaptation policies will require changes that affect the interests of various stakeholders. There is to date very little knowledge of the attitudes and beliefs of some of the most powerful stakeholders in the state (e.g., developers). Research on their interests, beliefs, and attitudes can help inform communication and outreach efforts, policy design, and those groups' decision support needs.

• Risk communication research related to climate change is a critical research need. It is, for example, well known that experts (scientists), resource managers and lay people (affected stakeholders) have very different risk perceptions. These perceptions inform but do not alone determine people's responses (e.g., to fire risks, to drought). Research is needed to better understand these perceptions, what does or doesn't change people's mental models, attitudes and behaviors.

A different way of making decisions

For science to support decisions, an openness and receptivity for that information is also required on the side of the practitioners. Even the best and most useful science does not constitute decision support if it is not actually used by decision-makers. A number of changes thus should be supported to increase the likelihood that practitioners want, need, and use scientific information and engage with scientists in defining exactly what is needed.

- Mandates that require the consideration of climate change in ongoing and long-term decision-making and planning are maybe the quickest way to mainstreams climate change into decision-making. It will rapidly create an information need. More generally, requirements to no longer use historical trends as the basis for forward projections as is traditionally the case but to engage in scenario-based planning and using climate change informed trends will foster a deep change in decision-making practices. Examples from any sector could be given when opportunities arise to mandate long-term thinking.
- To the extent managers' professional success can be redefined (e.g., through changes in job descriptions and agency missions that include consideration of the future and specifically climate change), there will be a personal motivation on the part of practitioners to engage the issue. Such structural changes would shift the incentives and references of accountability for decision-makers.
- Agency leaders must foster a learning culture in their institutions, e.g., by removing disincentives for risk taking, punishments for earnest mistakes, or providing rewards for trying/evaluating/revising decisions or management approaches (fostering adaptive learning).
- Bringing climate and social science expertise into agencies is a difficult proposition when budgets are tight, yet agency staff are increasingly in need of such knowledge, skills, and expertise. Some possible remedies may include bringing post-docs into agencies (and with them fresh science and innovative ideas, while the post-docs gain valuable practical experience); educating existing personnel through invited outside experts, training workshops, or web-based courses; establishing clearinghouses of information and case studies from which managers can (and will be expected) to learn. In some instances significant resistance from staff can be expected (just as with any person being asked to change), and the education effort should be repeated and ongoing. Where financially possible to bring social and climate scientists or broadly trained, scientifically literate managers into agencies (e.g., into leading positions), such opportunities should not be missed.

- There are international efforts underway at present (e.g., in the UK⁹) that are aiming to identify skills, knowledge and qualifications that employers and employees need to respond effectively to climate change. This exercise could be undertaken in each of the relevant CA state agencies.
- Funding interns to gather local-level information (e.g., valuable economic or ecological information exists in reports in dusty basements but is not widely available or accessible), "organizing information for utility", and bringing it online in commonly accessible (e.g., GIS) formats, would be a valuable step forward. This type of information would help local planners or state-level resource managers make growth planning decisions; land purchase decisions; preservation planning decisions and so on.

Building and fostering a network of decision support institutions

Once an inventory of climate decision support institutions at various levels and for all climate sensitive sectors exist, it will be critical to foster ways to network them, occasionally bring them together, ensure that their efforts are not at cross-purposes, and that the information used (e.g., climate scenarios) are not at odds.

Most experts interviewed for this paper supported the idea of a distributed network of decision support providers with a central coordinating function in an apolitical state-level institution (i.e., leadership not by a political appointee). For example, the California Climate Change Center was applauded, but viewed as too limited in scope, not inclusive of the system-wide resources available, and supported by inadequate resources to do more than it already does and currently ill-equipped or positioned to provide this coordinating function. For some sectors or agencies or stakeholders it would simply not be seen as the trusted, nearby source of information that would be needed. While collaboration across decision support providers would be desirable and should be strongly encouraged, competition and turf issues can get in the way. Incentives to collaborate and financial support thus will be critical.

Experience with some existing centers show that it is naïve to think "if you build it they will come": underfunded or stop-and-go-funded decision support centers that are "struggling to keep the lights on" can only take on small projects, rather than spend the time to acquire the level of funding support needed to provide effective, long-term decision support. It may be advisable to think through a range of funding mechanisms and sources, including state agencies, big foundations (Packard, Hewlett, California Foundation, etc.), and maybe a less significant but complementary role for businesses.

It is clearly important to recognize that different information users have different information and decision support needs, capacities, and strengths. A core group of leaders should be established to guide the building of a coordinated decision support effort, pull together the issues and "connect the dots" for people, but also allow for much localized flexibility in how the specific decision support needs are met.

In addition, an effort should be made by state agencies to better promote the decision support services of identified or newly created institutions so that decision-makers know where they can get strategic technical advice.

⁹ See http://www.exeter.ac.uk/climatechange for details.

In summary, California needs a long-term strategy to build decision support capacity. Overcoming the structural impediments and building institutions is difficult. To be more strategic, however, decision support should maybe start small in many different places and sectors with processes that will build trust; have a long-term plan to build a more integrated process with broader integrated perspectives.

Engaging the wider social scientific community

While beyond the scope of this paper alone, the experts consulted for this project discussed various options for increasing input from the social sciences in California climate change matters and in decision support. The overarching recommendation is that the state (maybe under PIER leadership) should support an effort to identify the pros and cons and possible structures of such an endeavor.

Possible strategies and models to increase social science input include and may not be limited to the following:

- Specific funding mechanisms (see above) for social scientists and widely advertised among them in the state and beyond;
- Call for well-integrated multi-disciplinary research projects; a state-level advisory panel could guide selection and priorities, help define "ground-rules", and help evaluate progress (which will take some time to show);
- Involvement of social scientists on agency task forces and advisory committees; consider having a standing social science advisory committee to inform and guide PIER and broader state efforts;
- Broadening of the consultancy basis;
- At the annual climate change conference, explicit and growing focus on social science contributions. At the same time it is important to recognize that periodic conferences won't substitute for ongoing research funding or institutionalized contributions. They can, however, bring focus and attention to an issue and help build a research agenda around it.
- A California Research Council (equivalent to the National Research Council, a research arm for federal agencies and Congress), may be one interesting model to build greater decision support capacity at the state level, but care should be taken to minimize bureaucracy; some experts urged that such an institution be non-partisan and independent like the Hoover Commission; even independent from the UC system;
- A California Human Dimensions Program (equivalent to the International Human Dimensions Program), which would essentially hold coordinating and facilitative functions, provide a focal point and enable and facilitate integrated social science research. Care would need to be taken to make it open, easily accessible, and inclusive, the research agenda would need to be carefully built with top-down leadership and bottom-up input from the wider social science community. A standing coordinating committee and small staff with operating grants would be needed

• Multi-campus research projects may be another mechanism to bring together social science research strengths from across the UC system.

In general, experts consulted for this paper saw a plethora of opportunities, mechanisms, and institutional models to jump-start and build a sustained effort to increase social science contributions in support of California's climate change research and policy agenda. They saw an opportunity to build a model for such input for the US more generally and strongly encouraged movement in this direction.

7.0 Conclusions and Prioritized Recommendations

7.1 Conclusions

Once again, it is important to distinguish research needs and needs to change practice and build institutions when it comes to building decision support. The latter may well be more important but institution building and practice building doesn't easily fit into a research-focused program. Some changes are possible through requirements in the way research is conducted or demands on stakeholder engagement. But the topic of this paper invites a broader discussion.

7.2 Prioritized Recommendations for Decision Support Research

PIER research funds are prioritized according to the following criteria: (1) relevance to PIER objectives (i.e., concerning the energy sector); (2) likelihood of generating scientifically and/or policy-relevant results within no more than four-to-five years; (3) potential applicability to California policy-making related to climate change; (4) technical quality and potential to advance scientific understanding; (5) potential to generate "co-benefits" (i.e., in science or policy not directly related to climate change); (6) likelihood of eventually securing co-funding from other agencies; and (7) the clear need for state support to reach the level of funding necessary to address these issues adequately.

The research topics identified above are subjectively and summatively rated (by the author) in the table below according to these criteria using a simple three-point scale (1 – low rating; 2 – medium rating; 3 – high rating).

Suggested Research Focus	PIER Evaluation Criteria (numbering follows description in text)									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	Total		
Research on decision support	2-3	3	3	3	3	1-2	1-2	16-18		
Research <u>for</u> decision support	2-3	3	3	2-3	3	1-2	3	17-20		

The PIER Program has only a limited history of funding research in this area. Moreover, decision support is not simply a matter of "doing the right kind of research" to produce allegedly the "right kind of information". Building decision support capacity requires changes in practice in how scientists and decision-makers work together, including how research priorities get set. The criteria assessed above may in fact be meaningless, if the

science-practice interaction and communication does not change. Research <u>on</u> decision support would be all but of academic interest, if the findings do not inform how to best design decision support institutions and processes for the state in different regions and sectors. Research <u>for</u> decision support will only be useful if it is selected, designed, informed, assisted and reviewed by decision-makers. Unless they are involved in setting these research priorities, the work undertaken may not be decision-relevant at all.

Ideally, then, the practices currently employed to decide on research priorities should be changed. The California Energy Commission may thus also include in its deliberations the following considerations¹⁰:

- Academics tend to have different perspectives on what the most important research priorities should be compared to what policy-makers, resource managers, or different stakeholders in the wider public believe they ought to be. The August 20-24, 2008 workshop offers one important (but maybe not sufficient) opportunity for non-academics to provide critical complementary, "corrective" input into the ranking of research priorities. For example, decision-makers at the local level or in the business community have very different information and knowledge service needs than state agency personnel or legislative staff, and not all will be equally represented at the Sacramento workshop.
- What is "policy relevant" in Sacramento (an explicitly stated endpoint of PIER-funded research) may not also be "decision relevant" at other levels of governance. Moreover, it is not inherently clear which specific policy goals are to be met (e.g., risk reduction, equity, economic benefit, or some measure of sustainability). Prioritization by the PIER criteria does not answer these questions. The research prioritization process for decision support needs to be rethought in principal to build California's decision support capacity.
- Programmatic balance can be achieved by a number of different metrics, including balance relative to stated program goals, balance by sector, balance by research that produces results relevant to short-term decision needs or more basic research that will result in policy relevance only after significant investment and maturation, or balance that aims to fill research gaps previously not addressed (e.g., a greater balance between physical, ecological, economic and other social scientific research). Decision support, always accompanied by a sense of urgency ("we need this information NOW"), to be truly useful or in service of societal goals, may sometimes require investment in developing basic knowledge and understanding. A longer term perspective and strategy to build decision support capacity should be employed.
- The criteria used above to rank research topics are not weighted, though clearly different experts, agency staff and stakeholders may assign different importance to them. Thus, the ranking total is almost certainly misleading. Deliberate,

¹⁰ This section draws heavily on a discussion paper by Roger Kasperson, a member of the NRC Committee reviewing progress of, and proposing research strategies for, the U.S. CCSP.

structured decision processes would be required to rank these research priorities appropriately.

Summary

The novelty and challenge of work in this arena should not undermine its perceived importance (and hence be placed low on the priority list). As a first and critical step, PIER could play an important initiatory and facilitating role in stimulating discussions in the state – in the agencies and with the broader scientific community on how to build decision support capacity over, say, a 5-year period. The strategies proposed in this report hopefully serve as discussion starters for a committed, creative, and ambitious effort to place climate-related decision-making in California on a more solid, broadly informed footing.

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Appendix 1: Expert Consultations

The following experts have been consulted for input to this White Paper. Most spoke to the Vulnerability/Adaptation focus <u>and</u> to the Decision Support focus, as well as related questions about social science contributions to policy-relevant climate change research

in California, so they are listed for this and the complementary paper.

Name Affiliation Exp		Expertise	Sector	Vulnerability	Decision	Bigger	
		1		Adaptation	Support	picture	
Meg	Stanford	Law, land use	coastal,		, î	Î	
Caldwell		policy, coastal	land use	х	x	х	
		mgmt				<u> </u>	
Kirstin Dow	University	Vulnerability,	water,				
	of South	adaptation,	general	x	х		
	Carolina	risk, HDGEC					
Judith	MBARI	Economics,	coastal,	×	Х	×	
Kildow		policy analysis	marine				
Helen	UC-Irvine,	Water, decision	water,		x	x	
Ingram	Univ. Ariz.	support	agricult.				
Roger	Clark	Vulnerability, adaptation, risk	General				
Kasperson	Casperson University			X		X	
Durkh	LIC Comto	HDGEC	Mater				
Ruth Langridge	UC-Santa Cruz	Water mgmt, conflicts	Water	x			
Jay Lund	UC-Davis	Water mgmt,	Water				
Jay Luliu	OC-Davis	engineering	vvatei		x		
Daniel	University	Governance,	general				
Mazmanian	of Southern	institutions,	sustaina-	x	х	х	
Mazmanan	California	env. policy	bility		Α	^	
Max Moritz	UC-	Extension spec.,	Forests				
	Berkeley	wildfire			х		
Paty	NCAR	Vulnerability,	urban,				
Ramero-		adaptation,	agricult.	x			
Lankao		urban areas					
Peter	UC-Davis	Cultural	General				
Richerson		evolution,		x		x	
		adaptation					
Roberto	UC-	Urban, vuln.,	Urban				
Sanchez-	Riverside	US-Mexico		X	x	x	
Rodriguez		relation, HDGEC					
Steve	Stanford	Climate-society	General				
Schneider		interactions,		Х		x	
Flains	LIC Indian	risk, extremes	ricks				
Elaine Vaughan	UC-Irvine	Risk perception, communication	risks, health	v		х	
Vaugilali		vuln., responses	HEAILII	X		, x	
Anthony	UC-Merced	Economics,	Forests				
Westerling	JC-IVIEICEU	forests, wildfire	1016363	х	Х		
Steve	UC-Davis	Land use	land use,				
Wheeler	50 241.0	planning	agricult.	х			
Oran Young	UC-Santa	Institutions,	General				
3	Barbara	HDGEC		Х	Х	x	
	parnara	חטטבע					